Unit 14

SPHERICAL MIRRORS AND LENSES

Q. Write the contribution of Ibn-ul-Haithum in the study of light.

Ans. Ibn-ul-Haitham was a Muslim scientist. Who is known in the field of light and optics

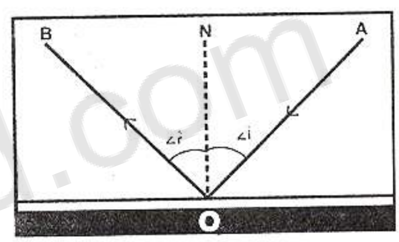
(1) He gave the laws of reflection of light experimentally.

(2) He studied the laws of refraction and recognized that the angle of incidence and angle of refraction have some relation with each other. This relation was studied six hundred year later by Willebrord Snell, a Dutch scientist.

Q. Describe Laws of Reflection. (L. B '09)

Ans. **Reflection of Light:**

The bouncing back of light from the shining surface is called Reflection of Light.



Laws of Reflection:

There are two laws of Reflection:-

(1) Angle of incidence is equal to angle of reflection.

i.e. $\angle \hat{i} = \angle \hat{r}$

(2) The incident ray, reflected ray, normal at the point of incidence lie in the same plane.

Q. What are Spherical Mirrors? Define the following terms. (L. B '10)

(1) Radius of Curvature **(2) Pole** **(3) Aperture**

(4) Principal axis **(5) Principal focus**

(6) Focal Length **(7) Radius of Curvature**

Ans. **SPHERICAL MIRROR:**

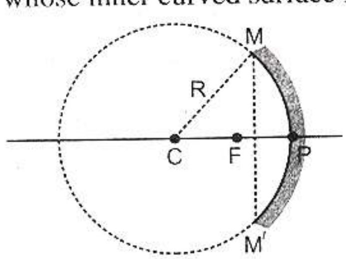
A portion of reflecting surface of a hollow sphere called Spherical Mirror.

Types of Spherical Mirror:-

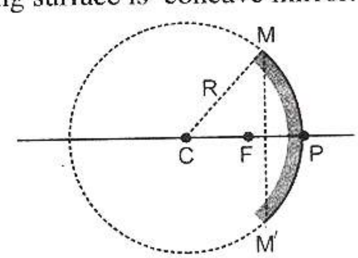
(i) Concave Mirror (ii) Convex Mirror

(i) Concave Mirror:

: The mirror whose inner curved surface is reflecting surface is concave mirror.



Concave Mirror



Convex Mirror

(ii) Convex Mirror:

The mirror whose outer curved surface is reflecting surface is called convex mirror.

Centre of Curvature:

The center 'c' of the sphere of which a concave mirror or convex mirror is a part is known as center of curvature.

(1) <u>Radius of Curvature:</u>

Radius of sphere of which convex mirror or concave mirror is a part is called radius of curvature.

(2) <u>Pole:</u>

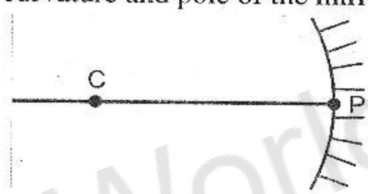
The center 'P' of the mirror is called pole.

(3) <u>Aperture:</u>

The front section of spherical mirror is circular one and its diameter is known as the aperture.

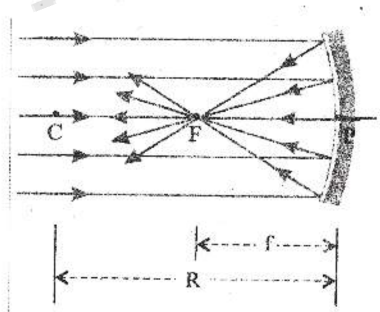
(4) <u>Principal Axis:</u>

The line joining the center of curvature and pole of the mirror is called principal axis.



(5) <u>Principal Focus:</u>

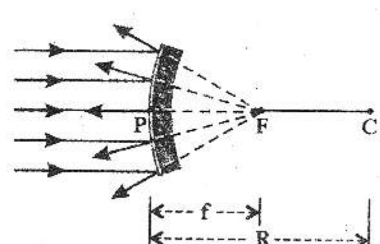
The ray of light parallel to principal axis after reflection through concave mirror converge to a point is called principal focus. As the rays are actually pass through this point so it is called real focus (F).



(6) <u>Principal Focus of Convex Mirror:</u>

The rays parallel to principal axis after reflection appear to come from a point F behind the mirror is called principal focus of convex mirror.

The principal focus of a convex mirror is virtual, because reflected rays do not actually pass through it.



(7) <u>Focal Length:</u>

The distance between pole and principal focus of a mirror is called focal length. The radius of curvature of a spherical mirror twice of its focal length i.e.

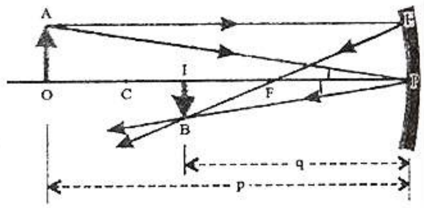
$$f = \frac{R}{2}$$

$$R = 2f$$

Focal length of a concave mirror is positive and is negative for convex mirror.

Q. Derive Spherical Mirror Formula:

Ans. Concave Mirror Formula:



The characteristic and location of an image formed by a spherical mirror can be determined from an equation which is called spherical mirror formula.

Derivation:

Consider an object OA is placed in front of mirror. A ray of light from point 'A' parallel to principal axis. Strike at point 'E' and after reflection it pass through 'F'. Another ray of light from A strike at the pole of the mirror. It is reflected making angle f reflection equal to the angle of incidence and intersect the first ray at the point B. Thus points B is the real image of point A.

Similar Triangles:

Now the triangle ΔAPO and ΔIPB are similar.

Angle of incidence APO = Angle of Reflection IBP.

Moreover one angle is of 90^{o}.

When triangles are similar then there corresponding sides are in proportion

So, $\frac{OA}{IB} = \frac{OP}{IP}$ --------------------(1)

Similarly ΔPEF and ΔIFB are similar

$\angle IFB = \angle PFE$

So $\frac{PE}{IB} = \frac{FP}{IF}$ But

So $\frac{OA}{IB} = \frac{PF}{IF}$ ---------- (2)

By comparing (1) and (2)

$$\frac{OP}{IP} = \frac{PF}{IF}$$

$$IF = IP - FP$$

$$\frac{OP}{IP} = \frac{FP}{IP - PF}$$

$$IP = q$$

$$PF = f$$

$$\frac{p}{q} = \frac{f}{q - f}$$

$$p(q - f) = qf$$

$$pq - pf = qf$$

PE = OA

FP = f

IF = q − f

Remember

P = distance of object from mirror

q = distance of image from mirror

f = focal length

Dividing both sides by pqf

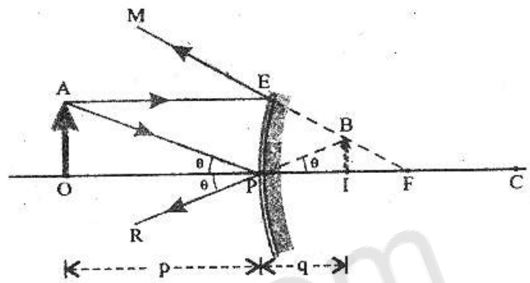
$$\frac{pq}{pfq} - \frac{pt}{pqf} = \frac{qf}{pqf}$$

$$\frac{1}{f} - \frac{1}{q} = \frac{1}{p}$$

$$\boxed{\frac{1}{f} = \frac{1}{p} + \frac{1}{q}}$$

Convex Mirror Formula:

Consider an object is placed in front of convex mirror. A ray of light from point 'A' parallel to principal axis strike at point E and after reflection have path EM. If this ray is produced in backward direction, it meet the principal axis at point F, this ray appears to diverged at from 'F'.



Another ray from point A strike at P and reflected back at the same angle. If this ray is produced in backward direction it will intersect the ray at B.

Hence IB is virtual image of OA. This image is virtual, erect and diminished. If 'p' is distance of object from pole of mirror, q is the distance of image from mirror and 'f' is focal length. Then convex mirror formula is:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

The value of 'f' and 'q' are taken as negative for convex mirror.

Q: Write the sign Convention of mirror.

Ans: Sign Convention:

It is very important to define sign convention so that we may be able to distinguish between real and virtual image.

The following rules are used for sign convention.

(1) All distance are measure from pole.
(2) Distance of real image and object is positive.
(3) Distance of virtual images is taken as negative.

Linear Magnification:

The ratio of the height of the image to that of object height is called linear magnification:

$$\text{Magnification} = m = \frac{\text{image height}}{\text{object height}} = \frac{IB}{OA} = \frac{IP}{OP} = \frac{q}{p} \quad \text{------(1)}$$

$$\text{Magnification} = m = \frac{\text{image height}}{\text{object height}} = \frac{q}{p}$$

Q. Describe the uses of spherical mirror. (L. B '08)

Ans. (1) The concave mirror is used by doctors for the examination of ear, nose, throat and eyes.

(2) Convex mirrors are used in motor cycles and automobiles which enables the driver to see the automobiles coming behind him.

(3) Concave mirror are used for shaving because when a man stands between the principal focus and pole of a concave mirror, he sees an enlarged erect and virtual image of his face.

(4) A concave mirror is used in microscope so that slides can be viewed clearly.

(5) Now-a-days America and other developed countries use giant concave mirror in huge telescope.

(6) They are used in search light to throw an intense beam of light at large distance.

(7) These are used in automobiles motor cycles which enables the driver to see the automobile coming behind him.

Q. What is meant by Refraction?

Ans. **REFRACTION:**

The deviation of light from its incident path while entering from one transparent medium to another.

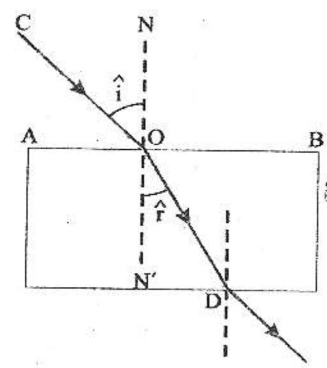
Q. What are laws of Refraction?

Ans. There are two laws of Refraction:

(1) For any refracting surface, the incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

(2) When a ray of light enters from one medium to another medium, the ratio of the sine of angle of incidence ($\angle i$) to the sine of angle of refraction '$\angle$r' is constant. This constant ratio is called Refractive index of second medium with respect to the first and it is denoted by 'x'

i.e. Refractive index $= n = \frac{\sin \hat{i}}{\sin \hat{r}}$



This ratio is called Snell's law.

A ray of light which in the medium at angle 90°, it will go straight in the 2nd medium.

Refractive index of medium may also define as the ratio of speed of light in vacuum or air to the speed of light in that medium.

$$n = \frac{\text{speed of light in air}}{\text{speed of light in glass}}$$

$$n = \frac{c}{v}$$

Speed of light in air is $3 \times 10^8\ ms^{-1}$ while speed of light in glass is $2 \times 10^8 ms^{-1}$

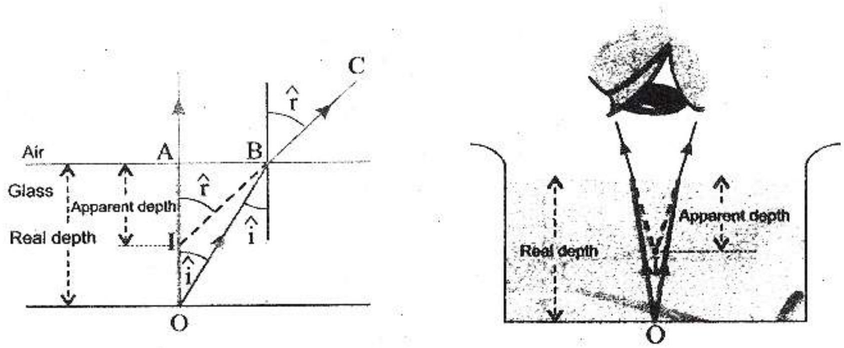
$$n = \frac{3x10^8\, ms^{-1}}{2x10^8\ ms^{-1}}$$

Refractive index of air with respect to glass = 1.5

Q. What is real and apparent depth? Derive a relation of refractive index to real and apparent depth. **(L. B '10)**

Ans. A pond of clear water appear to be shallower that it really is. Similarly, the pebbles lying at the bottom of the clear water of a river appear to be raised up above their actual position.

Relation of refractive index with real and apparent depth.



Explanation:

Consider 'O' is a bright point below a glass slab. A ray OA from 'O' perpendicular to the surface of the medium passes straight in to air. Consider another ray 'OB' from 'O' which is refracted along BC at the point B, because air is a rare medium, so angle of refraction is greater than the angle of incidence. If 'CB' to produced backward, it meets the first ray OA at point-" I ". For observer, the object 'O' appear as it were at I above 'O'.

Thus I is the virtual image of light object 'O'. If refractive index of glass is 'n', with respect to air, then according to Snell's law the refractive index of air with respect to glass in "$\frac{1}{n}$".

Then $$\frac{1}{n} = \frac{\sin \hat{i}}{\sin \hat{r}}$$

$$n = \frac{\sin \hat{r}}{\sin \hat{i}}$$

$$\sin \hat{r} = \frac{AB}{IB}$$

$$\sin \hat{i} = \frac{AB}{OB}$$

$$n = \frac{\frac{AB}{IB}}{\frac{AB}{OB}} = \frac{AB}{IB} \times \frac{OB}{AB} = \frac{OB}{IB}$$

If B is very close to A, then

$$OB = OA$$

$$IB = IA$$

then $$n = \frac{OA}{IA} = \frac{\text{real depth}}{\text{apparent depth}}$$

Q: Define critical angle. Also prove that $n = \frac{1}{\text{Sin}\angle C}$

Critical Angle: (L. B '08)

"The angle of incidence in the denser medium for which corresponding angle of refraction is 90^o, in the rare medium is called the critical angle. It is denoted by 'c'."

If refractive index of air with respect to glass is n. thus refractive index of ray OD from glass to air is $\frac{1}{n}$

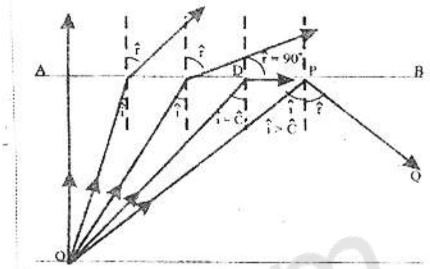
According to Snell's Law

$$\frac{1}{n} = \frac{\sin\angle i}{\sin\angle r} \qquad \therefore \qquad \angle i = \angle C$$

$$\frac{1}{n} = \frac{\sin\angle C}{\sin 90^o}$$

$$= \frac{\sin\angle C}{1}$$

$$n = \frac{1}{\sin\angle C}$$



Q. What is total internal reflection?write its conditions (L. B '08, 09)

Ans. When a ray of light passes from denser medium to rare medium, the refracted ray bends away from normal and the angle of refraction is greater than angle of incidence. If we increase the angle of incidence ($\hat{i}$) the angle of refraction ($\hat{r}$) also increases, till a particular value of angle of incidence, the corresponding angle of refraction becomes 90^o and refracted ray becomes parallel to the surface AB.

Total internal Reflection

When the value of angle of incidence becomes greater than the critical angle, then the ray does not enter in to the 2nd medium, but reflects back in the same medium such reflection of light is called total internal reflection.

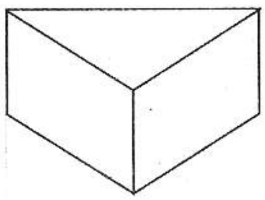
Conditions for Total Internal Reflection:

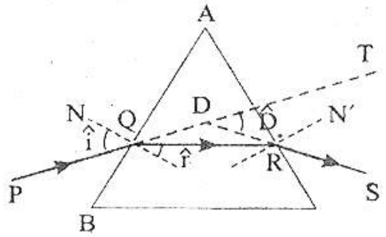
(1) The ray of light should travel from denser medium to rarer medium.

(2) The angle of incidence should be greater than the critical angle.

Q. Explain refraction through prism.

Ans. A prism is transparent body having three, rectangular and two triangular surfaces.





Angle of Prism:

The angle of the triangular surface opposite to the base is known as angle of prism.

Explanation of Refraction:

Consider a ray PQ strikes at the side AB of the prism. Then on entering the prism of the ray bends towards the normal at the point of incidence Q, i.e. bends towards the base of prism and

refracted ray QR on coming out of the prism bends away from the normal RN' at the point of emergence R i.e. the emergent ray RS bends towards the base of the prism.

The incident ray PQ makes an angle of incident $\hat{i}$ and $\hat{r}$ is its corresponding angle of refraction in the prism.

According to the Law of Refraction.

$$n = \frac{\sin\hat{i}}{\sin\hat{r}}$$

n is refractive index of the prism.

Angle of deviation:

The original direction of incidence ray is PQT, but it is turned through an angle TDS on passing through prism.

Dependence of angle of deviation:

The angle of deviation depends upon angle of incidence. If angle of incidence increase from a small value, the angle of deviation first decrease, reaches a minimum value then start increasing.

Angle of minimum deviation:

The minimum value of angle of deviation is known as the angle of minimum deviation and is written as D_m.

Refractive index with respect to air:

The refractive index of the prism with respect to air can be determined by:

$$n = \frac{\sin\frac{(A+D_m)}{2}}{\sin\frac{A}{2}}$$

Where 'A' is angle of prism.

Dispersion:

Definition:

The splitting of white light into seven colours when it is refracted through the prism is called dispersion.

Explanation: The refraction of waves depends upon their wave length. Since the light consist of different colours, the waves of different wavelengths thus when passes through a prism, then the waves of different wave length deviate on different path, due to this white light disperses into different colours which is called dispersion.

Solar Spectrum:

The band of colour which is seen on the screen is called solar spectrum.

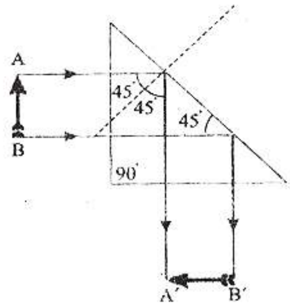
Q. Explain Totally Reflecting Prism. How can we use it as

(i) periscope (ii) Prism Binocular (iii) Projector

Ans. A totally reflecting prism has one of its angle equal to 90° and each of remaining two angles are equal to 45°. Hence the phenomenon of total internal reflection is used.

(i) Periscope:

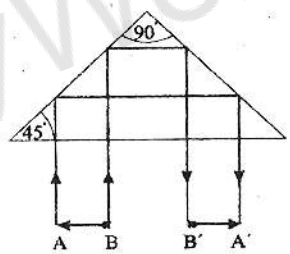
The critical angle of glass is 42°. If a ray is incident on one of its face perpendicularly. It enters the prism with out any change of direction and meet the hypotenuse at an angle of 45°. As the angle of incidence is greater than critical angle, the ray will be totally reflected the angle of reflection being 45°, The reflected ray thus strike the other face perpendicularly and comes out of the prism, and is deviated at an angle of 90°.



The rays from body AB are deviated through an angle of 90° and emerge at the prism as A′B′. Due to this fact, the prism is used in periscope.

(ii) Prism Binocular:

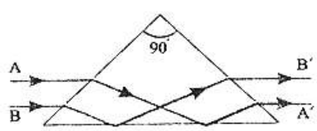
If the prism deviates the incident ray coming from the object AB through an angle of 180° and emerge out of the prism A′B′ after twice-total internal reflection inside the prism. Due to this these prisms are used in Prism Binoculars. A Prism Binocular is made by using two telescope separated at a distance equal to the distance between two eyes.



(iii) Projector:

Totally internal reflecting prism is used to erect the image of an object.

To invert the rays coming from an object. For example such prism is placed in front of a projector will show an erect image on the screen of an inverted slide or film placed on the other end of the projector.



Q. Write a note on optical fibre.

Ans. Optical fibres are of very thin diameter tube, which is made by highly transparent material glass or plastic coated or cladded with another type of glass whose refractive index is less than the inner tube. Usually index of inner tube is 1.52 and that of outercoating is 1.48.

Principle:

An optical fibre based on the principle of total internal reflection.

Working:

If light ray enter at one end of an optical fibre at an angle of incidence greater than the critical angle, then these rays undergo total internal reflection repeatedly at the walls and comes out at the other end without loss of intensity.

Light Pipe:

If several thousand fine strands of optical fibre are bundled together then a flexible light pipe is obtained which is used by doctors and engineers to illuminate those inaccessible places which otherwise are not possible to examine.

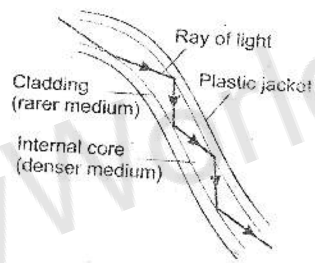
Uses:

(1) In developed countries, optical fibre are used in telecommunication and other modern communication system.

(2) Optical fibres are very light in weight more flexible and much cheaper than copper cables A bundle of 30 optical fibres are often used to from a cable.

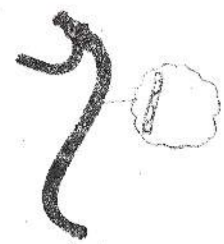
(3) The transmitting capacity of light pipes is thousand times greater than that of radio waves.

(4) Through optical fibres we have thousand of telephones calls at the same time without interfering each other.



ENDOSCOPE:

Endoscope is an instrument, which is used for viewing and photographing of the internal structure of human body by using light pipes.



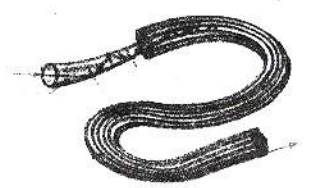
Endoscope

TYPES:

Endoscope are of different types, which are as follows.

- **Gastroscope:**
  It is an instrument which is used to view stomach.
- **Branchoscope:**
  It is an instrument used to view sore throat.
- **Cystoscope:**
  This instrument is used to examine liver.

In endoscope by using a bundle of optical fibres, the affected part is illuminated and it is viewed by another bundle of optical fibre. A video camera is fitted outside this bundle and this makes the interior visible to the surgeon, which helps him to diagnose easily.



The image of the interior of body can be seen through light pipes.

Q. What is Rainbow? Discuss briefly the primary and secondary Rainbow. Also write their colour pattern. (L. B '07, 08)

Ans. An arc of spectral colours which appears in the sky after rainfall due to refraction as well as dispersion of light is called Rainbow.

Endoscope

Rainbow-a natural phenomenon

Conditions:

(1) The sun should be at the back of the observer.

(2) The sunrays fall obliquely, which is possible only in the morning and evening.

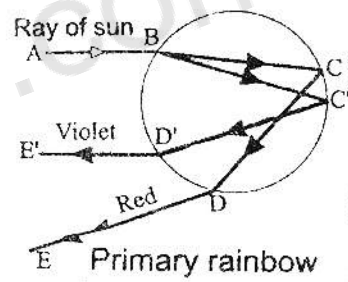
Nature of Rainbow:

The rainbow is a solar spectrum, which is produced due to the dispersion of light.

After rain innumerable droplets of water remains suspended in air. When sunrays fall on these droplets each droplet behave like a prism and light suffers refraction and total internal reflection. Since these ray are of white light so they split up into seven colours.

Primary Rainbow:

"The rainbow which has brightest colour and is easily visible is called primary rainbow".



Primary rainbow

Formation

In primary rainbow light suffer only one time total internal reflection.

Colour Pattern

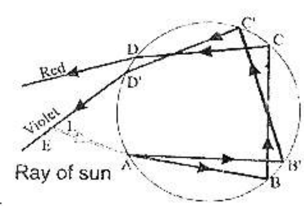
Primary rainbow has red colour on its outer and violet colour on the inner edge. The order of colour in primary rainbow is red, orange, yellow, green, blue, indigo and violet.

Secondary Rainbow:

Sometime a secondary rainbow beyond the outer edge of the primary rainbow is seen which is called secondary rainbow. It is fainter than primary rainbow and is seldom visible.

Formation of Secondary Rainbow:

It is formed when the rays from the sun suffer double total internal reflection. Due to two internal reflection in the water droplets causes the colour bands of the secondary rainbow to be in reverse order than in primary rainbow i.e. outer edge is violet, and inner edge is red.



Secondary Rainbow

Colour Pattern

The order of colour is violet, indigo blue, green, yellow, orange and red.

Q. Derive Lens Formula.

Ans. The equation used to study the characteristic of an imaged formed by a lens is called lens formula.

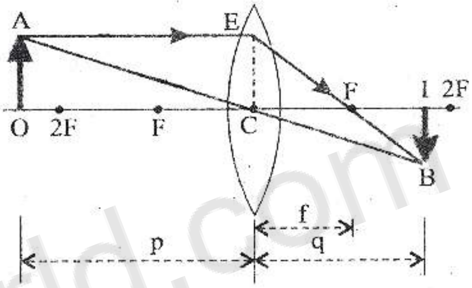
Convex Lens Formula:

Consider an object OA is placed in front of a convex lens. Ray of light from point A move parallel to principal axis strikes the lens at point E and after refraction it pass through focus point F.

A second ray AC passes through optical center of the lens and moves straight. It intersect the first ray at point B. If this process is repeated for all points of the object OA then real image IB of the object OA is obtained.

Consider triangle ΔOAC and ΔIBC are similar because $\angle ACO$ and $\angle BCI$ are equal. Also one angle is 90^o.

$$\frac{OA}{IB} = \frac{OC}{IC} \text{ -------------------------(1)}$$



Now consider ΔEFC and BFI are similar

$\frac{CE}{BI} = \frac{CF}{FI}$ But CE = OA then

$$\frac{OA}{IB} = \frac{CF}{FI} \text{ ------------------- (2)}$$

then on comparing 1 & 2

$$\frac{OC}{IC} = \frac{CF}{FI} \text{ ------------------- (3)}$$

$\therefore$ FI = q-f

OC = P

CF = f

IC = q

Then eq. (3) becomes

$$\frac{P}{q} = \frac{f}{q-f}$$

q(q—f) = vf

pq—pf = qf

dividing by pqf on both side

$$\frac{\cancel{Pq}}{\cancel{Pq}f} - \frac{\cancel{Pf}}{\cancel{P}q\cancel{f}} = \frac{\cancel{qf}}{P\cancel{qf}}$$

$$\frac{1}{f} - \frac{1}{q} = \frac{1}{P}$$

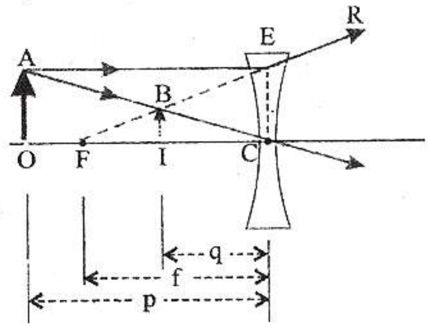
It can be written as

$$\boxed{\frac{1}{f} = \frac{1}{p} + \frac{1}{q}}$$

Concave Lens Formula:

An object OA is placed in front of concave lens. A ray from point A move parallel to the principal axis and strike the lens at point E, which is refracted along ER. A secondary ray AC

passing through optical center of the lens and is refracted straight when ray RE is produced backward it passes through focus 'F' and appear to intersect the ray AC at point B.



Thus 'B' is the virtual image of A. If this process is repeated for the object OA then the virtual image IB is formed of OA which is erect and diminished. Since concave lens always gives virtual image. Therefore according sign convention, the distance is taken as negative and focal length is always negative.

Therefore the formula is given by

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Linear Magnification:

The ratio of size of image to that of the size of object is called linear magnification.

$$m = \frac{\text{image height}}{\text{object height}}$$

$$m = \frac{IB}{OA} = \frac{IC}{OC} = \frac{q}{p}$$

Unit : It has no unit. Because it is ratio between two same quantities.

Sign of Convention:

(1) All distance are measured from optical center.

(2) The distance of real image is taken +ve and those for virtual image is taken -ve.

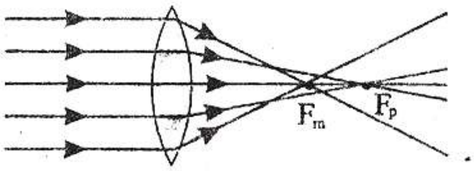
(3) The focal length for convex lens is +ve and –ve for concave lens.

Q. Describe Main defects of Lens.

Ans. There are two main defects of lens:

(1) Spherical aberration (2) Chromatic Aberration

(1) Spherical Aberration:



Definition: The rays which passes through thick lenses or lenses of large apparture do not focus at single point, so the image forms are not sharp and well define. This is called spherical aberration.

Reason:

If parallel ray of monochromatic light are incident on a lens, then marginal rays near the rim of lens after refraction, focus at F_m near to the lens, but the paraxial rays (rays, near the axis) are focus at F_p farther points, then at F_m. So the image formed is not sharp and well defined.

Minimization of defect:

i. Disc Method

By covering the lens with disc of equal size to the lens and having small hole at the center of this disaisk. This disc allows only the central or paraxial rays to pass through the central part of the lens but cut of marginal rays.

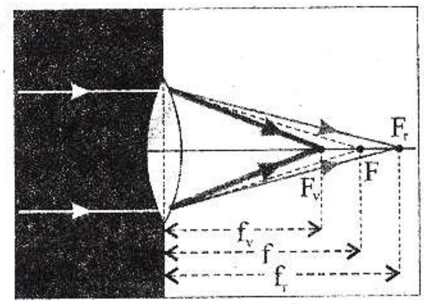
This method is used in cheap optical instruments.

ii. Complicated lens method

In expensive instruments, this defect is removed by using a complicated lens made by combining lens of different shapes.

Chromatic aberration:

When an object is illuminated by white light and viewed through cheap convex lens shows coloured tinge in the image, which make the image blurred. This defect is called chromatic aberration.



Reason:

A lens acts like two prism placed end to end. Thus white light passing through a lens is refracted as well as dispersed.

Hence violet rays are focused nearest the lens and red rays are focused at the farthest away. This defect is called chromatic aberration.

Minimization:

i. Achromatic lens method:

This defect can be minimized by combining a convex lens of crown glass and concave lens of flint glass in such a way that dispersion of light produced by convex lens is neutralized by concave lens. Such combination is called Achromatic lens (Colour corrected lens).

ii. Complicated method:

In high class camera and optical instrument a complicated combination of lenses is used.

Q. What do you understand by Power of Lens?

Ans. If the focal length of a lens is **"f"** then its reciprocal $\left(\frac{1}{f}\right)$ is called the power of the lens.

power of lens = P = $\frac{1}{f}$.

Where 'f' is measured in meter, then power of lens is in dioptre.

Unit:

The unit of power is dioptre.

DIOPTRE:

The power of lens of a focal length of one meter. Its symbols D.

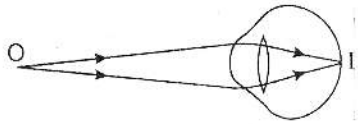
Power of concave lens is negative, because focal length is negative. Optician and eye specialist use the power of lens instead of focal length.

Q. What are main defects of vision and how are they removed?

Ans. **Normal Vision:**

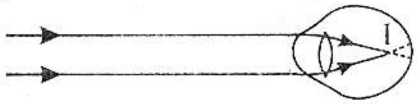
A normal eye can see object clearly at a far off distance down to about 25cm from the eye. This is called normal vision. There are two main defects of eye.

(1) Short sightedness (2) Long sightedness



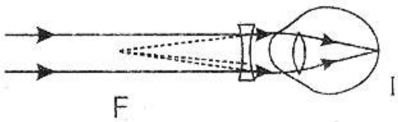
(1) Short Sightedness:

A man suffering from short sightedness cannot see distant object clearly but can see near objects clearly is called short sightedness.



Reason:

This defect may be due to that either the lens of the eyeball is thick i.e. focal length is short.
or
The eyeball is larger than the suitable size.



Hence the image of distant object is formed in front of the retina instead of at retina the actual far point of such an eye is near the eye instead of infinity.

Correction:

This defect can be corrected by wearing spectacles with cancave lens. These lens diverge the rays of light so that they appear to be coming from the eyes own far point, so they are focused on retina.

Long Sightedness:

A man suffering from long sightedness can see distant objects clearly but cannot see near object clearly is called long sightedness.

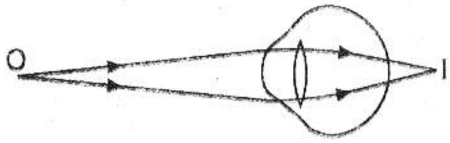
Reason:

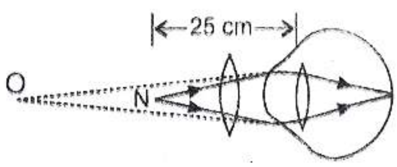
This is caused by an eyeball which is shorter than the normal size or eye lens is thinner, i.e. less converging. This means that light rays do not focus at retina but behind the retina.

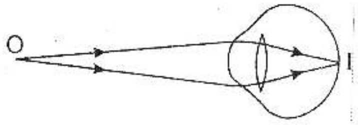
A man suffering from this defect is unable to read printed page of a book held at normal point 25 cm because the near point of such an eye is greater than 25 cm.

Correction:

This defect is corrected by wearing spectacle having convex lens of such focal length which forms virtual image of the object placed at 25 cm, at near point 'O' of the eye. Hence clear image is formed on retina.







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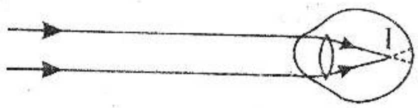
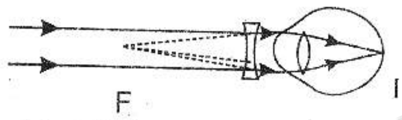


Reason:

This defect may be due to that either the lens of the eyeball is thick i.e. focal length is short. or

The eyeball is larger than the suitable size.



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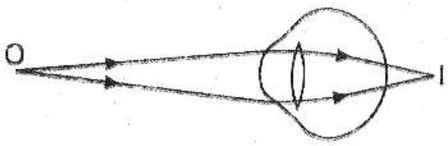
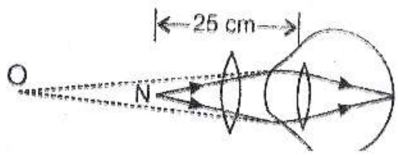
This defect is corrected by wearing spectacle having convex lens of such focal length which forms virtual image of the object placed at 25 cm, at near point 'O' of the eye. Hence clear image is formed on retina.





EXAMPLES

Example 14.1:

An object is placed at a distance of 30 cm from a concave mirror. Find the nature and position of the image if the focal length of the mirror is 5 cm. (L. B '10)

Solution:

The given data is

Distance of object = p = 30 cm

Focal length = f = 5 cm

i. Position of image = q = ?

ii. Nature = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{5} = \frac{1}{30} + \frac{1}{q}$$

$$\frac{1}{5} - \frac{1}{30} = \frac{1}{q}$$

$$\frac{6-1}{30} = \frac{1}{q}$$

$$\frac{5}{30} = \frac{1}{q}$$

$$\frac{1}{6} = \frac{1}{q}$$

$$q = 6 \text{ cm}$$

Nature: As 'q' is positive, so image is real and inverted.

Example 14.2:

How far from a concave mirror of focal length 20cm. Would you place an object to set an image three times enlarged?

Solution:

The given data is

Focal length = f = 20cm

Magnification : = m = 3

Distance of object = p = ?

(i) **When image is real:**

$$m = \frac{q}{p}$$

Putting values, we get

$$3 = \frac{q}{p}$$

$$3p = q$$

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{3p}$$

$$\frac{1}{f} = \frac{3+1}{3p}$$

$$\frac{1}{f} = \frac{4}{3p}$$

$$3p = 4f$$

$$p = \frac{4}{3}f$$

$$= \frac{4}{3}(20)$$

$$\boxed{P = 26.7\text{cm}}$$

(ii) When image is virtual.

In this case value of 'q' is with negative sign, or

$-3p = q$

Putting this value in the mirrors formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

We get

$$\frac{1}{20} = \frac{1}{p} - \frac{1}{3p}$$

$$\frac{1}{20} = \frac{3-1}{3p}$$

$$3p = 2f$$

$$p = \frac{2}{3}f$$

$$= \frac{2}{3} \times 20 \text{ cm}$$

$$= \frac{40}{3} \text{ cm}$$

$$\boxed{P = 13.3 \text{ cm}}$$

Example 14.3:

The real depth of a swimming pool is 2m. What is the apparent depth of the pool if the refractive index of water is 1.33?

Solution:

The given data is

Real depth = 2m

Apparent depth = ?

Refractive index = 1.33

Of water

Formula:

$$\text{Refractive index} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

Putting values, we get

$$1.33 = \frac{2}{\text{Apparent depth}}$$

OR

$$\text{Apparent depth} = \frac{(2)}{1.33}$$

$$\boxed{\text{Apparent depth} = 1.5\ \text{m}}$$

Example 14.4:

The focal length of a convex lens is 20 cm. Where an object should be placed so as to get its real image magnified four times?

Solution:

The given data is

Focal length = f = 20 cm

Distance of object = p = ?

Magnification = m = 4

For real image:

For a real image we write

$$m = \frac{q}{p}$$

$$4 = \frac{q}{p}$$

$$4p = q$$

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{4q}$$

$$\frac{1}{20} = \frac{1}{p} + \frac{1}{4q}$$

$$\frac{1}{20} = \frac{4+1}{4p}$$

$$\frac{4}{5 \times 20} = \frac{1}{p}$$

$$\frac{1}{p} = \frac{4}{100}$$

$$\frac{1}{p} = \frac{1}{25}$$

$$\Rightarrow p = 25 \text{ cm}$$

For virtual image:

As image is virtual, so its distance from optical centre of lens is written with negative sign, as follows.

$$m = \frac{-q}{p}$$

$$4 = \frac{-q}{p}$$

$$4p = -q \quad \text{or} \quad q = -4p$$

Putting this value in lens formula, we get.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{-4q}$$

$$\frac{1}{20} = \frac{1}{p} - \frac{1}{4q}$$

$$\frac{1}{20} = \frac{4-1}{4p}$$

$$\frac{1}{20} = \frac{3}{4p}$$

$$\frac{4}{60} = \frac{1}{p}$$

$$\frac{1}{15} = \frac{1}{p}$$

$$p = 15 \text{ cm}$$

Example 14.5:

An object is situated at a distance of 10cm from a concave lens of focal length of 15 cm. Calculate the position, nature and magnification of the image.

Solution:

The given data is
Distance of object = p = 10 cm
Focal length = f = 15 cm
Distance of image = q = ?
Magnification = m = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{15} = \frac{1}{10} + \frac{1}{q}$$

$$-\frac{1}{15} - \frac{1}{10} = \frac{1}{q}$$

$$\frac{-2-3}{30} = \frac{1}{q}$$

$$\frac{-5}{30} = \frac{1}{q}$$

$$q = -6 \text{ cm}$$

This shows that image is virtual because sign of q is negative. It is erect.

Hence q = 6 cm

And value of magnification is given by.

$$m = \frac{q}{p} = \frac{6}{10}$$

$$\boxed{m = 0.6}$$

Example 14.6:

The near point of person is 50 cm and his far point is 200 cm. Calculate the power of the lenses, which his spectacles should have (i) for reading (ii) to see clearly the distance objects.

Solution:

The person is suffering both from long sightedness and short sightedness.

i. Correction of long sightedness here near point of the person = 50 cm

Normal near point of the eye = p = 25cm

(i) **For long sightedness**

The lenses used for long sightedness are concave in nature, therefore, we use formula.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \quad \text{(for virtual image)}$$

Here

p = 25 cm

q = -50 cm

Putting values, we get

$$\frac{1}{f} = \frac{1}{25} - \frac{1}{50}$$

$$= \frac{2-1}{50}$$

$$\frac{1}{f} = \frac{1}{50 \text{ cm}}$$

$f = 50cm$

$f = 0.5\ m$

$$P = \frac{1}{f(m)} = \frac{1}{0.5}$$

$P = 2\ D$

Hence power of lens is = 2 D

(ii) For Short Sightedness

For short sightedness the lenses used are concave. Also, here we put.

$p = \infty$

$q = -200\ cm$

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{f} = \frac{1}{\infty} - \frac{1}{200}$$

$$\frac{1}{f} = \frac{-1}{200}$$

$f = -200\ cm$

$f = -2m$

$$p = \frac{1}{f\ (m)} = \frac{1}{2} = 0.5D$$

$\mathbf{p = 0.5D}$

NUMERICAL PROBLEMS

14.1: An object is placed at a distance of 10 cm from a concave mirror. If the radius of curvature of the concave mirror is 15 cm, determine the position, nature and magnification of the image.

Solution:

The given data is

Distance of object = p = 10 cm

Radius of curvature = R = 15 cm

Focal length = f = $\frac{R}{2}$ = 7.5 cm

Distance of image = q = ?

Linear magnification = m = ?

Nature = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{10}{75} = \frac{1}{10} + \frac{1}{q}$$

$$\frac{1}{q} = \frac{10}{75} - \frac{1}{10}$$

$$= \frac{20-15}{150}$$

$$\frac{1}{q} = \frac{5}{150}$$

$$q = \frac{\overset{30}{\cancel{150}}}{\cancel{5}}$$

$$q = 30 \text{ cm}$$

As value of 'q' is positive so we can say that image is real. Its magnification is given by formula.

$$\text{Magnification} = \frac{q}{p}$$

Putting value, we get

$$m = \frac{30}{10}$$

$$\boxed{m = 3}$$

This shows that size of image is 3 times the size of object.

14.2: A lighted candle is placed 12 cm from a convex mirror. If the focal length of the mirror is 15 cm and height of the candle is 4.5 cm, find the position, nature and size of the image.

Solution:

The given data is

Distance of object = p = 12 cm

Focal length of convex mirror = f = -15 cm

Height of object = 4.5 cm

Distance of image = q = ?

Size of image = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{-15} = \frac{1}{12} + \frac{1}{q}$$

$$-\frac{1}{15} - \frac{1}{12} = \frac{1}{q}$$

$$-\left(\frac{1}{15}+\frac{1}{12}\right) = \frac{1}{q}$$

$$-\left(\frac{12+15}{15 \times 12}\right) = \frac{1}{q}$$

$q = -6.67$ cm $\boxed{q = -6.67cm}$

The value of q is negative, this shows that image is virtual

By definition we write.

$$\text{Magnification} = \frac{\text{size of image}}{\text{size of object}} = \frac{q}{p}$$

Putting value, we get

$$\frac{\text{size of image}}{4.5\text{cm}} = \frac{6.67}{12}$$

$$\text{Size of image} = \frac{6.67}{12} \times 4.5 \text{ cm}$$

$\boxed{\text{size of image} = 2.5 \text{ cm}}$

14.3: An object 1 cm high is placed at distance of 15 cm from a convex lens of focal length 10 cm. Determine the nature, position and size of the image.

Solution:

The given data is

Size of object = h_o = 1 cm

Distance of object = p = 15 cm

Focal length = f = 10 cm

Distance of image = q = ?

Nature of image = ?

Size of image = h_i = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{10} = \frac{1}{15} + \frac{1}{q}$$

$$\frac{1}{10} - \frac{1}{15} = \frac{1}{q}$$

$$\frac{15-10}{(10)\times(15)} = \frac{1}{q}$$

$$\frac{5}{(10)\times(15)} = \frac{1}{q}$$

$\boxed{q = 30 \text{ cm}}$

Size of image = hi = ?

We know:

$$\frac{hi}{h_o} = m$$

$h_i = h_o \times m$

$= 1 \times 2$

$h_i = 2$ cm

As value of 'q' is positive, so the image is real, and inverted.

m= Also magnification $= \frac{q}{p} = \frac{30}{15} = 2$

This shows that image is magnified to twice the size of object.

14.4: An object 2 cm high is placed in front of a convex lens of focal length 14 cm, where should the object be placed so as to get a real image 4 cm high.

<u>Solution:</u>

The given data is

Size of object $= h_o = 2$ cm

Focal length $= f = 14$ cm

Size of image $= h_i = 4$ cm

Distance of object $= p = ?$

<u>Formula:</u>

Putting the values in the following formula, we get.

$$m = \frac{\text{size of image}}{\text{size of object}} = \frac{4}{2} = 2$$

Also $m = \frac{q}{p}$ But $m = 2$

$$\frac{q}{p} = 2$$

$$q = 2p$$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{p} + \frac{1}{2p} = \frac{1}{f}$$

Putting values, we get

$$\frac{3}{2p} = \frac{1}{14}$$

$$\frac{3}{2} \times 14 = p$$

$$\boxed{P = 21 \text{ cm}}$$

14.5: An object 6 cm high is placed at a distance of 20 cm from a concave lens of focal length 10 cm. Calculate the position, nature and size of the image.

<u>Solution:</u>

The given data is

Size of object $= h_o = 6$ cm

Distance of object = p = 20 cm

Focal length = f = - 10cm

Distance of image = q = ?

Nature = ?

Size = ?

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{-10} = \frac{1}{20} + \frac{1}{q}$$

$$-\frac{1}{10} - \frac{1}{20} = \frac{1}{q}$$

$$\frac{2-1}{20} = \frac{1}{q}$$

$$q = \frac{-20}{3}$$

$$\boxed{q = -6.67 \text{ cm}}$$

Image is virtual because sign of q is negative.

Formula:

$$m = \frac{\text{size of image}}{\text{size of object}} = \frac{q}{p} = \frac{6.67}{20} = \frac{1}{3} = 0.33$$

Also $\frac{h_i}{h_o} = m$

$h_i = m \times 40$

$= 0.33 \times 6$

$\boxed{h_i = 2\text{cm}}$

14.6: The speed of light in air is 3.0 x 10^8 ms^{-1}. If the refractive index of the diamond is 2.42 then find the speed of light in it.

Solution:

The given data is

Speed of light in air C = 3 x$10^8 ms^{-1}$

Refractive index of diamond = n = 2.42

Speed of light in diamond=v = ?

Formula:

$$\text{Refractive index} = \frac{\text{speed of light in air}}{\text{speed of light in diamond}}$$

$$n = \frac{c}{v}$$

Putting values, we get

$$2.42 = \frac{3 \times 10^8}{v}$$

$$v = \frac{3}{2.42} \times 10^8$$

Ans

14.7: The depth of pond is 4m. What is the apparent depth of the pond if the water is 3.5 m high? The refractive index of water is 1.33.

Solution:

The given data is

Actual depth of a pond = 4m

Apparent depth of pond = ?

Water level = 3.5 m

Refractive index of water = 1.33

Formula:

$$\text{Refractive index} = \frac{\text{real depth of water}}{\text{apparent depth of water}}$$

Putting values, we get

$$1.33 = \frac{3.5}{\text{apparent depth}}$$

$$\text{Apparent depth} = \frac{3.5}{1.33}$$

$$= 2.63 \text{ m}$$

Height above water level = 4m – 3.5m = 0.5m

So corrected apparent depth = 0.5m + 2.63m

$$= \boxed{3.13\text{m}} \text{ Ans}$$

14.8: The power of a convex lens is 10 D. The object is placed at what distance from the lens so that its real and 3 times larger image is formed?

Solution:

The given data is

Power of convex lens = P = 10 D

Distance of object = p = ?

Magnification = m = 3

Formula:

$$m = \frac{q}{p}$$

$$m \times p = q$$

Putting values, we get

$$\boxed{3p = q}$$

Formula:

$$\text{power} = \frac{1}{\text{focal length (meters)}}$$

$$f_{(m)} = \frac{1}{\text{power}}$$

$$= \frac{1}{10D}$$

$$f_{(m)} = 0.1m$$

$$= 10 \text{ cm}$$

Formula:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values, we get

$$\frac{1}{10} = + \frac{1}{3p}$$

$$\frac{1}{10} = \frac{4}{3p}$$

$$p = \frac{4}{3} \times 10$$

$$\boxed{p = 13.3 \text{ cm}}$$

MULTIPLE CHOICE QUESTIONS

Q. Circle the correct answer.

1. Ibn-ul-Haithum discovered the laws of________ experimentally:
a) Reflection b) Refraction
c) a, b d) Rainbow

2. The first Muslim scientist who study light:
a) Ibn-ul-Haithum
b) Al-Kindi
c) Jaber-Bin-Hayat
d) Newton

3. The diameter of spherical mirror is called:
a) Curvature b) Aperture
c) Sphere d) a, b

4. The center of spherical mirror is called:
a) Focus b) Axis
c) Centre d) Pole

5. Half of radius of curvature is called:
a) Focal length b) Principal focus
c) Axis d) None of these

6. The point through which rays of light pass after reflection is called principal:
a) Focus b) circle
c) Axis d) radius

7. The distance between principal focus and pole of mirror is called:
a) Principal focus
b) focal length
c) P
d) image

8. The mirror whose inner surface is reflecting is called:
a) concave mirror
b) convex mirror
c) mirror d) lens

9. The mirror whose outer surface is reflecting is called:
a) concave mirror
b) convex mirror
c) lens d) mirror

10. The line which pass through pole of the mirror and center of curvature is called principal:
a) axis b) focus
c) line d) none of these

11. The ray of light after reflection through concave mirror passes through:
a) centre b) principal focus
c) pole d) none of these

12. Spherical mirrors are used in:
a) medical b) search light
c) microscope d) all these

13. Magnification of mirror is given by:
a) $m = \frac{p}{q}$ b) $m = \frac{q}{p}$
c) $m = p \times q$ d) $m = \frac{1}{p+q}$

14. The distance of the object from the mirror is represented by:
a) q b) p
c) m d) F

15. The distance of image from mirror is represented by:
a) q b) p
c) F d) m

16. Snell's law is:
a) $n = \frac{\sin < x}{\sin < r}$ b) $n = \frac{\sin < i}{\sin < r}$
c) $n = \frac{\sin < r}{\sin < i}$ d) $\frac{<i}{<r}$

17. Concave mirror formula is given by:
a) $R = 2f$ b) $\frac{\sin < i}{\sin < r}$
c) $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ d) $\frac{1}{f} = \frac{1}{p} - \frac{1}{q}$

18. Focal length for concave mirror is:
(2007 Group-I)
a) -ve b) +ve
c) Same d) none of these

19. Bouncing back of light after striking the surface is called:
a) refraction b) reflection
c) diffraction d) interference

20. The ratio of image height to object height is called:
a) linear magnification
b) power
c) refraction d) radius of curative

21. When a ray of light enter from denser medium to rare medium, the angle of incidence for which angle of refraction is 90^o is called: (L.B '04 G-II)
a) angle of incidence
b) critical angle
c) angle of refraction
d) none of these

22. The critical angle for glass is:
a) 24^o b) 48^o
c) 42^o d) 50^o

23. The critical angle for water is:
a) 49^o b) 42^o
c) 62^o d) 50^o

24. Critical angle for diamond is:
a) 60^o b) 24^o
c) 26^o d) 49^o

25. Angle opposite to the base of triangle of prism is called:
a) angle of incidence
b) angle of refraction

c) angle of prism
d) emerging angle

26. The ray of light striking to the side of prism is called:
a) refraction ray b) incident ray
c) reflected ray d) emergent ray

27. The minimum value of angle of deviation is called:
a) minimum angle
b) incident angle
c) angle of minimum deviation
d) none of these

28. The angle at which prism deviate the incident ray is called:
a) angle of incident
b) angle of reflection
c) angle of deviation
d) angle of minimum deviation

29. To see from submarine the ship at the surface of water, we use:
a) telescope b) microscope
c) periscope d) prism

30. In totally reflecting prism one angle is of:
a) 45° b) 90°
c) 180° d) 120°

31. In totally reflecting prism one angle is of 90°, and other two angles are of:
a) $30^\circ, 30^\circ$ b) $45^\circ, 90^\circ$
c) $45^\circ, 45^\circ$ d) $40^\circ, 40^\circ$

32. Totally reflecting prism is used in:
a) periscope b) binoculars
c) periscope and Binocular
d) telescope

33. Totally reflecting prism turn the incident ray at an angle of:
a) 90° b) 60°
c) 75° d) 45°

34. The refractive index of internal coating of optical fibre is:
a) 1.56 b) 1.51
c) 1.52 d) 1.58

35. Optical fibers are:
a) cheap b) flexible
c) lighter d) all these

36. To see stomach problems we use: (L.B '06 G-II)
a) gastroscope b) bronchoscope
c) cystoscope d) all these

37. Sun light consists of __________ colour:
a) 6 b) 5
c) 7 d) 2

38. The refractive index of air is:
a) 6 b) 1.003
c) 7 d) 2

39. The refractive index is represented by:
a) n b) M
c) A d) D

40. The refractive index of alcohol is:
a) 1.36 b) 1.47
c) 2.42 d) 1.33

41. The refractive index of flint glass is
a) 1.44 b) 1.66
c) 1.45 d) 1.33

42. The speed of light in glass is:
a) 3×10^8 m / sec
b) 2×10^8 m / sec
c) 4×10^8 m / sec
d) 5×10^8 m / sec

43. Power of concave lens is: (L.B '06 G-II)
a) positive b) negative
c) less d) greater

44. Linear magnification is the ratio between the:
a) Distance of object and image from mirror

b) Distance of object and object from the focal point
c) Distance of image and object from mirror
d) Distance of image from object and the distance of object from mirror

45. Focal length of concave lens is: (L.B '07 G-II)
a) Positive b) Negative
c) Greater d) Smaller

46. If the image is virtual, then its distance from lens is taken:
a) positive b) half
c) negative d) double

47. The main defect of lens is:
a) spherical aberration
b) chromatic aberration
c) a and b d) Short singleness

48. If the ray of light after refraction through thick lens are not focus at a single point, then this is called:
a) chromatic aberration
b) spherical aberration
c) both a and b
d) long sightedness

49. The defects in eyes are:
a) long sightedness
b) short sightedness
c) both a and b d) none of these

50. For long sightedness we use:
a) convex lens b) concave lens
c) concave mirror d) none

51. The refractive index of ice is:
a) 1.36 b) 1.30
c) 1.47 d) 1.66

52. The refractive index of glycerin is:
a) 1.36 b) 1.47
c) 2.42 d) 1.33

53. The refractive index of external layer of optical fibre is:
a) 1.52 b) 1.51
c) 1.48 d) 1.49

54. Power of lens is (L.B '05 G-I)
a) $\frac{q}{p}$ b) $\frac{1}{q}$
c) $\frac{1}{p}$ d) $\frac{1}{f}$

55. Speed of light in air is ms^{-1} (L.B '05 G-I)
a) 3×10^8 b) 340
c) 3×10^5 d) 3×10^{11}

56. A normal eye can see near objects clearly at a distance down to about (L.B '06 G-I)
a) 20 cm b) 25 cm
c) 30 cm d) 35 cm

57. Power of a convex lens is 10D. Its focal length is (L.B '04 G-I)
a) 100 m b) 10 m
c) 1 m d) 0.1 m

58. ______ is always virtual in case of convex mirror (L.B '10)
a) P b) Image
b) object d) All of these

ANSWERS

1.	a	2.	a	3.	b	4.	d	5.	a	6.	a	7.	b
8.	a	9.	b	10.	a	11.	b	12.	d	13.	b	14.	b
15.	a	16.	b	17.	c	18.	b	19.	b	20.	a	21.	b
22.	c	23.	a	24.	b	25.	c	26.	b	27.	c	28.	c
29.	c	30.	b	31.	c	32.	c	33.	a	34.	c	35.	d

36.	a	**37.**	c	**38.**	b	**39.**	a	**40.**	a	**41.**	b	**42.**	b
43.	b	**44.**	c	**45.**	b	**46.**	c	**47.**	c	**48.**	b	**49.**	c
50.	a	**51.**	b	**52.**	b	**53.**	c	**54.**	d	**55.**	a	**56.**	b
57.	d	**58.**	b										

GIVE SHORT ANSWER

Q.1: Which lens is used for the long sightedness?

Ans. A convex lens is used for the correction of long sightedness.

Q.2: What are spherical mirrors? Also write their type.

Ans. A portion of the reflecting surface of a hollow sphere in called spherical mirror. They are of two types.

i). Concave mirror ii) convex mirror

Q.3: Define concave mirror.

Ans. The mirror whose inner curved surface is reflecting is called concave mirror.

Q.4: Define center of curvature.

Ans. The center of sphere of which a concave or convex mirror is a part is called center of curvature.

Q.5: What is radius of curvature?

Ans. Radius of sphere of which a concave or convex mirror is a part is called the radius of curvature.

Q.6: Define aperture. **(L. B '09, 10)**

Ans. The front side of spherical mirror is circular. The diameter of this circle is called aperture.

Q.7: Define principal axis and principal focus.

Ans. The line passing through center of curvature and pole of mirror is called principal axis and the point at which rays after reflection converge is called principal focus.

Q.8: Distinguish between real and virtual image.

Ans. These image, which can be obtain on the screen is called real image and image, which cannot obtain on screen is called virtual image.

Q.9: Define focal length (L).

Ans. The distance between principal focus and pole of the mirror is called focal length.

Q.10: What is linear magnification? **(L. B '09, 10)**

Ans. The ratio of height of image to the height of the object is called linear magnification. It formula is $m = \frac{\text{height of image}}{\text{height of object}} = \frac{IB}{OA} = \frac{q}{p}$

Q.11: Define laws of refraction.

Ans.

(i) The refracted ray, incident ray and normal lie on the same plane.

(ii) The ratio of sine of angle of incidence to the sine of angle of refraction is constant. This constant is called refractive index.

Q.12: Define critical angle. **(L. B '08)**

Ans. The angle of incidence in denser medium for which the angle of refraction is 90° In rare medium is called critical angle.

Q.13: What is total internal reflection? **(L. B '08)**

Ans. When light enter from denser medium to rare medium, the angle of incident is greater than the critical angle, then the ray is reflected totally inside the same medium and does not emerge out from the denser medium. This is called total internal reflection..

Q.14: What is angle of deviation and minimum deviation? **(L. B '08)**

Ans. The angle at which prism deviates the incidence ray is called angle of deviation and the minimum value of angle of deviation is called angle of minimum deviation.

Q.15: Define totally reflecting prism.

Ans. The prism in which one angle is 90° and remaining two angles are of 45° each is called totally reflecting prism.

Q.16: For which purpose totally reflecting prism are used?

Ans. These are used in periscope, binoculars submarine, and in projectors.

Q.17: What are optical fibers? Write their uses.

Ans. Optical fibers are made of highly transparent fine strand of glass or plastic coated or cladded within another type of glass whose refractive index is less than inner tube.

Q.18: What is endoscope?

Ans. It is an instrument, which is used for viewing and photographing the internal structure of human body.

Q.19: Define rainbow and write its kinds.

Ans. These are of spectral colour appear in the sky after a rain fall is called rainbow. This is called rainbow its kinds are primary rainbow and secondary rainbow.

Q.20: Define primary and secondary rainbow.

Ans. The rainbow which has brightest in colours and is easily visible is called primary rainbow and rainbow appeared on the outer edge of the primary rainbow is called secondary rainbow.

Q.21: What should be angle of incidence for total internal reflection?

Ans. The angle of incidence must be greater than critical angle in order to get total internal reflection.

Q.22: Define spherical aberration?

Ans. The rays which pass through thick lens or lens of large aperture not focus at a point, so the image formed is not well defined and sharp is called spherical aberration.

Q.23: Define chromatic aberration?

Ans. The image illuminated by a white light trough a convex lens shows a colour and is not well defined this defect is called chromatic aberration.

Q.24: What are the types of defects in vision?

Ans. Many people cannot see objects clearly; have defects in their vision. There are two main defects of vision (i) Long sightedness (ii) Short sightedness

Q.25: To get a greater and clear image at what distance lens should be placed from the object?

Ans. The lens should be placed such that the object must be within focal length of lens, So as to get greater and clear image.

Q.26: What is long sightedness and how it is removed?

Ans. A person who can see distant objects clearly but cannot see near objects clearly is suffering from long sightedness. This defect can be removed by using convex lens of suitable focal length.

Q.27: Define prism.

Ans. A prism is a transparent object having two triangular and three rectangular sides. It is used to disperse light into seven colours.

Q.28: Write the conditions of total internal reflection.

Ans. There are two conditions of total internal reflection.

(1) Light should pass from denser medium to rare medium

(2) The angle of incidence should greater than critical angle.

Q.29: What is refraction of light?

Ans. When light enters from one medium, to another medium it changes its direction and velocity. This phenomenon is called refraction of light.

Q.30: What is reflection of light?

Ans. The bouncing back of light after striking the shiny surface is called reflection of light.

Q.31: Which lens has greater power, either of less focal length or of greater focal length?

Ans. The lens with less focal length has greater power because P= 1/f

Q.32: Which lens is used for long sightedness?

Ans. For short sightedness we use convex lens.

Q.33: To remove the defect of chromatic aberration which method is used?

Ans. To remove chromatic aberration we use combination of lens i.e a convex lens of crown glass and concave lens of flint glass.